THE AGB NEWSLETTER

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Editors: Jacco van Loon and Albert Zijlstra

Editorial

Dear Colleagues,

It is a pleasure to present you the 187$^{\rm th}$ issue of the AGB Newsletter. With no fewer than 51 (*sic!*) contributions this was a bit more work than usual but worth all the while. What about the pioneering investigations of the PNe in the centre of M 31 illuminating the UV upturn seen in elliptical galaxies, or their use to probe the interstellar dust in front of the Galactic Bulge; an abundance of work on variability from the Odessa group; the latest release of the UMIST database for astrochemistry; exciting new insight into all-familair objects – Betelgeuse and the Ring Nebula; radio stars (!) or lithium... and do AGB stars have got something to do with Kepler's supernova?

The announcements are not to be ignored: Martin Groenewegen kindly requests your input for a review; the ARTIST tool for submm radiative transfer may come in handy with the advent of ALMA; and the VLTI School advertised by Andrea Chiavassa is certainly a great way to venture into what is perceived as a specialist technique.

The next issue is planned to be distributed around the 1$^{\rm st}$ of March.

Editorially Yours,
Jacco van Loon and Albert Zijlstra

Food for Thought

This month's thought-provoking statement is:

Sometimes the answers are staring you in the face, too close to see.

Reactions to this statement or suggestions for next month's statement can be e-mailed to agbnews@astro.keele.ac.uk (please state whether you wish to remain anonymous)

Refereed Journal Papers

Linear polarization of submillimetre masers. Tracing magnetic fields with ALMA

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Once ALMA full polarization capabilities are offered, it will become possible to perform detailed studies of polarized maser emission towards star forming regions and late-type stars, such as (post-) asymptotic giant branch stars and young planetary nebulæ. In order to derive the magnetic field orientation from maser linear polarization, a number of conditions involving the rate of stimulated emission R, the decay rate of the molecular state Γ, and Zeeman frequency $g\Omega$ need to be satisfied. The goal of this work is to investigate if SiO, H_2O and HCN maser emission within the ALMA frequency range can be detected with observable levels of fractional linear polarization in the regime where the Zeeman frequency is greater than the stimulated emission rate. We have used a radiative transfer code to calculate the fractional linear polarization as a function of the emerging brightness temperature for a number of rotational transition of SiO, H_2O and HCN which have been observed to display maser emission at submillimetre wavelengths. We assume typical magnetic field strengths measured towards galactic star forming regions and circumstellar envelopes of late-type stars from previous VLBI observations. Since the Landé g-factors have not been reported for the different rotational transitions we have modeled, we performed our calculations assuming conservative values of the Zeeman frequency for the different molecular species. Setting a lower limit for the Zeeman frequency which still satisfies the criteria $g\Omega > R$ and $g\Omega > \Gamma$, we find fractional polarization levels of up to 13%, 14% and 19% for the higher J transitions analysed for SiO, H_2O and HCN, respectively, without considering anisotropic pumping or any other non-Zeeman effect. Such upper limits were calculated assuming a magnetic field oriented perpendicular to the direction of propagation of the maser radiation. According to our results SiO, H_2O and HCN maser emission within the ALMA frequency range can be detected with suitable linear polarization to trace the magnetic field structure towards star forming regions and late-type stars, even if the detected polarization has been enhanced by non-Zeeman effects.

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Available from arXiv:1301.0813

Modules for Experiments in Stellar Astrophysics (MESA): Giant planets, oscillations, rotation, and massive stars

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We substantially update the capabilities of the open source software package Modules for Experiments in Stellar Astrophysics (MESA), and its one-dimensional stellar evolution module, MESA Star. Improvements in MESA Star's ability to model the evolution of giant planets now extends its applicability down to masses as low as one-tenth that of Jupiter. The dramatic improvement in asteroseismology enabled by the space-based *Kepler* and CoRoT missions motivates our full coupling of the ADIPLS adiabatic pulsation code with MESA Star. This also motivates a numerical recasting of the Ledoux criterion that is more easily implemented when many nuclei are present at non-negligible abundances. This impacts the way in which MESA Star calculates semi-convective and thermohaline mixing. We exhibit the evolution of 3–8 $M_\odot$ stars through the end of core He burning, the onset of He thermal pulses, and arrival on the white dwarf cooling sequence. We implement diffusion of angular momentum and chemical abundances that enable calculations of rotating-star models, which we compare thoroughly with earlier work. We introduce a new

treatment of radiation-dominated envelopes that allows the uninterrupted evolution of massive stars to core collapse. This enables the generation of new sets of supernovæ, long gamma-ray burst, and pair-instability progenitor models. We substantially modify the way in which MESA Star solves the fully coupled stellar structure and composition equations, and we show how this has improved MESA's performance scaling on multi-core processors. Updates to the modules for equation of state, opacity, nuclear reaction rates, and atmospheric boundary conditions are also provided. We describe the MESA Software Development Kit (SDK) that packages all the required components needed to form a unified and maintained build environment for MESA. [Abridged]

Submitted to ApJ Supplement Series
Available from arXiv:1301.0319
and from http://mesastar.org/results/mesa2

First determination of an astrophysical cross section with a bubble chamber: the ^{15}N(α,γ)^{19}F reaction

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We have devised a technique for measuring some of the most important nuclear reactions in stars which we expect to provide considerable improvement over previous experiments. Adapting ideas from dark matter search experiments with bubble chambers, we have found that a superheated liquid is sensitive to recoils produced from γ-rays photo-disintegrating the nuclei of the liquid. The main advantage of the new target-detector system is a gain in yield of six orders of magnitude over conventional gas targets due to the higher mass density of liquids. Also, the detector is practically insensitive to the γ-ray beam itself, thus allowing it to detect only the products of the nuclear reaction of interest. The first set of tests of a superheated target with a narrow bandwidth γ-ray beam was completed and the results demonstrate the feasibility of the scheme. The new data are successfully described by an R-matrix model using published resonance parameters. With the increase in luminosity of the next generation γ-ray beam facilities, the measurement of thermonuclear rates in the stellar Gamow window would become possible.

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Doppler imaging of stellar surface structure XXIV. The lithium-rich single K-giants DP CVn and DI Psc

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Aims: We present the first Doppler imaging study of the two rapidly rotating, single K-giants DP CVn and DI Psc in order to study the surface spot configuration and to pinpoint their stellar evolutionary status.
Methods: Optical spectroscopy and photometry are used to determine the fundamental astrophysical properties. Doppler imaging is applied to recover the surface temperature distribution for both stars, while photometric light-curve inversions are carried out for studying the long-term changes of the surface activity of DP CVn. Surface differential rotation of DP CVn is estimated from cross-correlating the available subsequent Doppler reconstructions separated by roughly one rotation period.
Results: Both stars appear to have higher than normal lithium abundance, LTE $\log n$ of 2.28 (DP CVn) and 2.20 (DI Psc), and are supposed to be located at the end of the first Li dredge-up on the RGB. Photometric observations reveal rotational modulation with a period of 14.010 d (DP CVn) and 18.066 d (DI Psc). Doppler reconstructions from the available mapping lines well agree in the revealed spot patterns, recovering rather low latitude spots for both stars with temperature contrasts of $\Delta T \approx 600$–800 K below the unspotted photospheric background. Spots at

higher latitudes are also found but either with less contrast (DP CVn) or with smaller extent (DI Psc). A preliminary antisolar-type differential rotation with $\alpha = -0.035$ is found for DP CVn from cross-correlating the subsequent Doppler images. Long-term photometric analysis supports the existence of active longitudes, as well as the differential rotation.

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Theoretical estimates of stellar e-captures. I. The half-life of ^{7}Be in evolved stars

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The enrichment of Li in the Universe is still unexplained, presenting various puzzles to astrophysics. One open issue is that of obtaining reliable estimates for the rate of e-captures on ^{7}Be, for T and ρ conditions different from the solar ones. This is of crucial importance to model the Galactic nucleosynthesis of Li. In this framework, we present here a new theoretical method for calculating the e-capture rate in conditions typical of evolved stars. Furthermore, we show how our approach compares with state-of-the-art techniques for solar conditions, where various estimates are available. Our computations include: i) "traditional" calculations of the electronic density at the nucleus, to which the e-capture rate for ^{7}Be is proportional, for different theoretical approaches including the Thomas–Fermi, Poisson–Boltzmann, and Debye–Hückel (DH) models of screening; ii) a new computation, based on a formalism that goes beyond the previous ones, adopting a mean-field "adiabatic" approximation to the scattering process. The results obtained with the new approach as well as with the traditional ones and their differences are discussed in some detail, starting from solar conditions, where our approach and the DH model essentially converge to the same solution. We then analyse the applicability of both our method and the DH model to a rather broad range of T and ρ values, embracing those typical of red giant stars, where both bound and continuum states contribute to the capture. We find that, over a wide region of the parameter space explored, the DH approximation does not really stand, so that the more general method we suggest should be preferred. As a first application, we briefly reanalyse the ^{7}Li abundances in RGB and AGB stars of the Galactic Disk in the light of a revision in the Be-decay only; we however underline that the changes we find in the electron density at the nucleus would induce effects also on the electron screening (for p-captures on Li itself, as well as for other nuclei) so that our new approach might have rather wide astrophysical consequences.

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Strontium and barium In early-type galaxies

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The detailed abundance patterns of the stars within galaxies provide a unique window into the history of star formation (SF) at early times. Two widely used 'chronometers' include the α and iron-peak elements, which are created on short

and long timescales, respectively. These two clocks have been widely used to estimate SF timescales from moderate-resolution spectra of early-type galaxies. Elements formed via *s*-process neutron captures (e.g., Sr and Ba) comprise a third type of chronometer, as the site of the main *s*-process is believed to be intermediate and low-mass asymptotic giant branch stars. The [α/Ba] ratio in particular should provide a powerful new constraint on the SF histories of galaxies, in part because it is insensitive to the uncertain distribution of Type Ia SNe detonation times and the overall Ia rate. Here we present new measurements of the abundance of Sr and Ba in nearby early-type galaxies by applying stellar population synthesis tools to high S/N optical spectra. We find a strong anti-correlation between [Mg/Fe] and [Ba/Fe], and a strong positive correlation between [Mg/Ba] and galaxy velocity dispersion. These trends are consistent with the idea that more massive galaxies formed their stars on shorter timescales compared to less massive galaxies, and rule out several other proposed explanations for the observed super-solar [Mg/Fe] values in massive galaxies. In contrast, [Sr/Fe] $\sim$ 0, with no strong variation across the sample. It is difficult to interpret the Sr trends without detailed chemical evolution models owing to the multiplicity of proposed nucleosynthetic sites for Sr.

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Dielectronic recombination lines of C^+

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The current paper presents atomic data generated to investigate the recombination lines of C II in the spectra of planetary nebulæ. These data include energies of bound and auto-ionizing states, oscillator strengths and radiative transition probabilities, auto-ionization probabilities, and recombination coefficients. The R-matrix method of electron scattering theory was used to describe the C_2^+ plus electron system.

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White-dwarf red-giant mergers, early-type R stars, J stars and lithium

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Early-type R stars and J stars are a special type of carbon star, having enhanced nitrogen ([N/Fe] $\sim$ 0.5), lithium, a low $^{12}C/^{13}C$ ratio ($<$ 15) and no *s*-element enhancements. The merger of a helium white dwarf with a red giant is regarded to be a possible model for the origin of early-type R stars, but the details of nucleosynthesis are not clear. In this paper we investigate three possible channels for helium white-dwarf + red-giant mergers, and find that, amongst the three, only a high-mass helium white dwarf subducted into a low core-mass red giant can make an early-type R star. Nucleosynthesis of elements carbon, nitrogen, oxygen and lithium correspond well with the observations. Furthermore, we find that the J stars may represent a short and luminous stage in the evolution of an early-R star.

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The planetary nebulæ population in the nuclear regions of M 31: the SAURON view

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The study of extragalactic Planetary Nebulæ (PNe) in the optical regions of galaxies, where the properties of their stellar population can be best characterised, is a promising ground to better understand the late evolution of stars across different galactic environments. Following a first study of the central regions of M 32 that illustrated the power of integral-field spectroscopy (IFS) in detecting and measuring the [O III] λ5007 emission of PNe against a strong stellar background, we turn to the very nuclear PN population of M 31, within $\sim$ 80 pc of its centre. We show that PNe can also be found in the presence of emission from diffuse gas, as commonly observed in early-type galaxies and in the bulge of spirals, and further illustrate the excellent sensitivity of IFS in detecting extragalactic PNe through a comparison with narrow-band images obtained with the *Hubble* Space Telescope. Contrary to the case of the central regions of M 32, the nuclear PNe population of M 31 is only marginally consistent with the generally adopted form of the PNe luminosity function (PNLF). In particular, this is due to a lack of PNe with absolute magnitude M5007 brighter than -3, which would only result from a rather unfortunate draw from such a model PNLF. The nuclear stellar population of M 31 is quite different from that of the central regions of M 32, which is characterised in particular by a larger metallicity and a remarkable UV-upturn. We suggest that the observed lack of bright PNe in the nuclear regions of M 31 is due to a horizontal-branch population that is more tilted toward less massive and hotter He-burning stars, so that its progeny consists mostly of UV-bright stars that fail to climb back up the asymptotic giant branch (AGB) and only of few, if any, bright PNe powered by central post-AGB stars. These results are also consistent with recent reports on a dearth of bright post-AGB stars towards the nucleus of M 31, and lend further support to the idea that the metallicity of a stellar population has an impact on the way the horizontal branch is populated and to the loose anti-correlation between the strength of the UV-upturn and the specific number of PNe that is observed in early-type galaxies. Finally, our investigation also serves to stress the importance of considering the same spatial scales when comparing the PNe population of galaxies with the properties of their stellar populations.

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Catching the fish – Constraining stellar parameters for TX Psc using spectro-interferometric observations

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Stellar parameter determination is a challenging task when dealing with galactic giant stars. The combination of different investigation techniques has proven to be a promising approach. We analyse archive spectra obtained with the Short Wavelength Spectrometer (SWS) onboard ISO, and new interferometric observations from the Very Large Telescope MID-infrared Interferometric instrument (VLTI/MIDI) of a very well studied carbon-rich giant: TX Psc. The aim of this work is to determine stellar parameters using spectroscopy and interferometry. The observations are

used to constrain the model atmosphere, and eventually the stellar evolutionary model in the region where the tracks map the beginning of the carbon star sequence. Two different approaches are used to determine stellar parameters: (i) the "classic" interferometric approach where the effective temperature is fixed by using the angular diameter in the N-band (from interferometry) and the apparent bolometric magnitude; (ii) parameters are obtained by fitting a grid of state-of-the-art hydrostatic models to spectroscopic and interferometric observations. We find good agreement between the parameters of the two methods. The effective temperature and luminosity clearly place TX Psc in the carbon-rich AGB star domain in the H–R-diagram. Current evolutionary tracks suggest that TX Psc became a C-star just recently, which means that the star is still in a "quiet" phase compared to the subsequent strong-wind regime. This agrees with the C/O ratio being only slightly greater than 1.

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Two-component variability of the semi-regular pulsating star U Delphini

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Photometric analysis of photometric variability of the semi-regular pulsating variable U Del is analyzed. From the international AFOEV database, 6231 brightness values in the time interval JD 2,451,602–55,378 were chosen. For the periodogram analysis, we have used a trigonometric polynomial fit. Using the criterion of minimal variance of the approximation at arguments of observations, the optimal degree is $s = 1$. Initial epoch for maximum is $T_0 =$ JD 2453340(3), the period $P = 1198(4)$ d. Mean brightness at maximum is 6.624(5), at minimum 7.124(5), i.e. the amplitude is 0.499(5) mag. Besides this slow variability, there is a faster oscillation of a period of 119.45(6) d, amplitude 0.303(5) mag and an initial epoch for maximum 2453215.1(5). These results are mean during the time interval after that analysed in the catalogue of Chinarova & Andronov (2000). Also the method of "running sines" with a filter half-width $\Delta t = 0.5P$. The local mean (averaged over a short period) brightness varies in a range 6.58–7.41 mag, the semi-amplitude exhibits very strong variations from 0.01 to 0.46 mag. The phase is also variable – typically of a full amplitude of 0.5. Close to JD 2452589, occurred a phase jump by a complete period during a descending branch of a slow wave. This effect was not observed during other cycles. No significant correlation between mean brightness and amplitude of short-period oscillation was found. Despite significant variability of amplitude, the periodic contribution is not statistically significant. Also characteristics of individual brightness extrema were found. The study was made in a course of the international project "Inter-Longitude Astronomy" (Andronov et al. 2010) and national project "Ukrainian Virtual Observatory" (Vavilova et al. 2012).

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Non-local radiative transfer in strongly inverted masers

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Maser transitions are commonly observed in media exhibiting a large range of densities and temperatures. They can be used to obtain information on the dynamics and physical conditions of the observed regions. In order to obtain reliable constraints on the physical conditions prevailing in the masing regions, it is necessary to model the excitation mechanisms of the energy levels of the observed molecules. We present a numerical method that enables us to obtain self-consistent solutions for both the statistical equilibrium and radiative transfer equations. Using the

standard maser theory, the method of Short Characteristics is extended to obtain the solution of the integro-differential radiative transfer equation, appropriate to the case of intense masing lines. We have applied our method to the maser lines of the H_2O molecule and we compare with the results obtained with a less accurate approach. In the regime of large maser opacities we find large differences in the intensity of the maser lines that could be as high as several orders of magnitude. The comparison between the two methods shows, however, that the effect on the thermal lines is modest. Finally, the effect introduced by rate coefficients on the prediction of H_2O masing lines and opacities is discussed, making use of various sets of rate coefficients involving He, o-H_2 and p-H_2. We find that the masing nature of a line is not affected by the selected collisional rates. However, from one set to the other the modelled line opacities and intensities can vary by up to a factor ~ 2 and ~ 10 respectively.

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Miras or SRAs – the transient type variables

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The variability of several stars shows "Mira-type" and "semi-regular" behavior during long-time data ranges. Such data are available due to amateur visual observations from AAVSO and AFOEV databases. We have studied these properties by using different methods of time series analysis, such as the periodogram analysis using trigonometric polynomial fit, wavelet analysis and individual cycle characteristics analysis using the running parabola fit. As the result, very similar multi-periodicities were detected.

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The mathematical model of the photometric variability and classification of semi-regular pulsating asymptotic giants branch stars

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The modern review of the stars which are located at the position of asymptotic giant branch at the H–R diagram is presented. The most interesting problems connected to these objects are noted, as well as attention is paid to classification and to the evolutionary status. We provided mathematical modeling of the mean light curve of the semi-regular supergiant S Per. It is shown, that by means of the periodogram analysis, it is possible to determine the period of the main variability and to provide further detailed classification of semi-regular pulsating stars, approximating their mean light curves with a trigonometric polynomial. It is offered to use the photometric period for estimates of physical parameters of pulsing stars.

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Wavelet analysis of 173 semi-regular variables

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We made the wavelet analysis of 173 semi-regular pulsating variable stars of dierent sub-types. For the analysis, we have used 1,000,000 individual brightness estimates from the published international databases of the VSOLJ (Japan) and AFOEV (France). They were visually checked using the program OL (I.L. Andronov, 2001, OAP 14, 255A), and bad points were removed from the data

tables. The wavelet analysis was performed using the program WWZ (I.L. Andronov, 1998, KFNT 14, 490A) which improves the discrete Morlet-type wavelet transform to the case of irregularly spaced data. Mean weighted wavelet periodograms are presented, as well as wavelet maps. Dependences of the wavelet-based periods and amplitudes on time are presented for the investigated stars. Some stars exhibit switchings between preferred periods, which are interpreted as switchings of the pulsation mode. Additional criteria for classification of the pulsating variables based on the stability of periods and amplitudes are discussed. Results are shown for the semi-regular star RU And, for which the semi-amplitude varies drastically from 0.027 ("nearly constant star") to 1.204 mag ("Mira"-type pulsating variable. The phase of pulsations also varies drastically by $0.7P$, and the wavelet estimates of the period – from 210 to 270 days.

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The UMIST database for astrochemistry 2012

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We present the 5^{th} release of the UMIST Database for Astrochemistry (UDfA). The new reaction network contains 6173 gas-phase reactions, involving 467 species, 47 of which are new to this release. We have updated rate coefficients across all reaction types. We have included 1171 new anion reactions and updated and reviewed all photorates. In addition to the usual reaction network, we also now include, for download, state-specific deuterated rate coefficients, deuterium exchange reactions and a list of surface binding energies for many neutral species. Where possible, we have referenced the original source of all new and existing data. We have tested the main reaction network using a dark cloud model and a carbon-rich circumstellar envelope model. We present and briefly discuss the results of these models.

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Lithium-rich field giants in the Sloan Digital Sky Survey

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We present a search for post-main-sequence field stars in the Galaxy with atypically large lithium abundances. Using

moderate-resolution spectra taken as part of the Sloan Digital Sky Survey, along with high-resolution followup spectroscopy from the *Hobby–Eberly* Telescope, we identify 23 post-turnoff stars with $\log \epsilon$(Li) greater than 1.95, including 14 with $\log \epsilon$(Li)$>$ 2.3 and 8 with $\log \epsilon$(Li)$>$ 3.0, well above the low level expected for evolved stars. Comparison with theoretical isochrones indicates that some of our Li-rich stars are affiliated with the upper red giant branch, the asymptotic giant branch and the red clump rather than the RGB bump, which is a challenge to existing models of Li production in evolved stars.

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Stellar dust production and composition in the Magellanic Clouds

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The dust reservoir in the interstellar medium of a galaxy is constantly being replenished by dust formed in the stellar winds of evolved stars. Due to their vicinity, nearby irregular dwarf galaxies the Magellanic Clouds provide an opportunity to obtain a global picture of the dust production in galaxies. The Small and Large Magellanic Clouds have been mapped with the *Spitzer* Space Telescope from 3.6 to 160 μm, and these wavelengths are especially suitable to study thermal dust emission. In addition, a large number of individual evolved stars have been targeted for 5–40 μm spectroscopy, revealing the mineralogy of these sources. Here I present an overview on the work done on determining the total dust production rate in the Large and Small Magellanic Clouds, as well as a first attempt at revealing the global composition of the freshly produced stardust.

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X-ray emission from strongly asymmetric circumstellar material in the remnant of Kepler's supernova

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Kepler's supernova remnant resulted from a thermonuclear explosion, but is interacting with circumstellar material (CSM) lost from the progenitor system. We describe a statistical technique for isolating X-ray emission due to CSM from that due to shocked ejecta. Shocked CSM coincides well in position with 24 μm emission seen by *Spitzer*. We find most CSM to be distributed along the bright north rim, but substantial concentrations are also found projected against the center of the remnant, roughly along a diameter with position angle $\sim 100^\circ$. We interpret this as evidence for a disk distribution of CSM before the SN, with the line of sight to the observer roughly in the disk plane. We present 2-D hydrodynamic simulations of this scenario, in qualitative agreement with the observed CSM morphology. Our observations require Kepler to have originated in a close binary system with an AGB star companion.

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Lithium abundance in atmospheres of F- and G-type supergiants and bright giants

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Lithium in the atmosphere of a F or G supergiant reflects the initial Li abundance and the internal history of the star. During evolution of a star from the main sequence (MS) to the supergiant phase, lithium may be destroyed by, for example, rotationally induced mixing in the MS stars and strongly diluted by development of the supergiant's convective envelope. In order to probe the connection between atmospheric Li abundance and evolutionary predictions, we present a non-local thermodynamic equilibrium abundance analysis of the resonance doublet Li I at 6707.8 Å for 55 Galactic F and G supergiants and bright giants (we observed 43 of them, the remaining 12 are added from Luck & Wepfer's list). The derived lithium abundances $\log\epsilon$(Li) may be considered in three groups, namely: (i) 10 Li-rich giants with $\log\epsilon$(Li) = 2.0–3.2 (all 10 are F-type or A9 stars); (ii) 13 G- to K0-type stars with Li abundances in the narrow range $\log\epsilon$(Li) = 1.1–1.8; (iii) all other stars provide just upper limits to the Li abundance.

The derived Li abundances are compared with theoretical predictions of 2–15 $M_\odot$ stars (both rotating and non-rotating). Our results are generally in good agreement with theory. In particular, the absence of detectable lithium for the majority of programme stars is explainable. The comparison suggests that the stars may be separated by mass M into two groups, namely $M < 6$ $M_\odot$ and $M > 6$ $M_\odot$. All Li-rich giants and supergiants with $\log\epsilon$(Li) > 2.0 have masses $M < 6$ $M_\odot$; this conclusion follows not only from our work but also from a scrutiny of published data. 11 of 13 stars with $\log\epsilon$(Li) = 1.1–1.8, specifically the stars with $M < 6$ $M_\odot$, show good agreement with the post-first dredge-up surface abundance $\log\epsilon$(Li) = 1.4 predicted for the non-rotating 2–6 $M_\odot$ stellar models. An absence of Li-rich stars in the range $M > 6$ $M_\odot$ agrees with the theoretical prediction that F and G supergiants and giants with $M > 6$ $M_\odot$ cannot show detectable lithium.

We note that present theory appears unable to account for the derived Li abundances for some stars, namely for (i) a few relatively low-mass Li-rich giants ($M < 6$ $M_\odot$), whose high Li abundances accompanied by rather high rotational velocities or substantial nitrogen excess contradict theoretical predictions; (ii) the relatively high-mass supergiants HR 461 and HR 8313 ($M > 6$ $M_\odot$) with the detected abundances $\log\epsilon$ = 1.3–1.5. It is possible that the lithium in such stars was synthesized recently.

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Automated classification of *Hipparcos* unsolved variables

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We present an automated classification of stars exhibiting periodic, non-periodic and irregular light variations. The *Hipparcos* catalogue of unsolved variables is employed to complement the training set of periodic variables of Dubath et al. with irregular and non-periodic representatives, leading to 3881 sources in total which describe 24 variability types. The attributes employed to characterize light-curve features are selected according to their relevance for

classification. Classifier models are produced with random forests and a multistage methodology based on Bayesian networks, achieving overall misclassification rates under 12 per cent. Both classifiers are applied to predict variability types for 6051 *Hipparcos* variables associated with uncertain or missing types in the literature.

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Long-term photometry of three active red giants in close binary systems: V2253 Oph, IT Com and IS Vir

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We present and analyze long-term optical photometric measurements of the three active stars V2253 Oph, IT Com and IS Vir. All three systems are single-lined spectroscopic binaries with an early K giant as primary component but in different stages of orbital-rotational synchronization. Our photometry is supplemented by 2MASS and WISE near-IR and mid-IR magnitudes and then used to obtain more accurate effective temperatures and extinctions. For V2253 Oph and IT Com, we found their spectral energy distributions consistent with pure photospheric emission. For IS Vir, we detect a marginal mid-IR excess which hints towards a dust disk. The orbital and rotational planes of IT Com appear to be coplanar, contrary to previous findings in the literature. We apply a multiple frequency analysis technique to determine photometric periods, and possibly changes of periods, ranging from days to decades. New rotational periods of 21.55 ± 0.03 d, 65.1 ± 0.3, and 23.50 ± 0.04 d were determined for V2253 Oph, IT Com, and IS Vir, respectively. Splitting of these periods led to tentative detections of differential surface rotations of $\Delta P/P \sim 0.02$ for V2253 Oph and 0.07 for IT Com. Using a time-frequency technique based on short-term Fourier transforms we present evidence of cyclic light variations of length ~ 10 yr for V2253 Oph and 5–6 yr for IS Vir. A single flip–flop event has been observed for IT Com of duration 2–3 yr. Its exchange of the dominant active longitude had happened close to a time of periastron passage, suggesting some response of the magnetic activity from the orbital dynamics. The 21.55-d rotational modulation of V2253 Oph showed phase coherence also with the orbital period, which is 15 times longer than the rotational period, thus also indicating a tidal feedback with the stellar magnetic activity.

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Kn 26, a new quadrupolar planetary nebula

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Once classified as an emission line source, the planetary nebula (PN) nature of the source Kn 26 has been only recently recognized in digital sky surveys. To investigate the spectral properties and spatio-kinematical structure of Kn 26, we have obtained high spatial-resolution optical and near-IR narrow-band images, high-dispersion long-slit échelle spectra, and intermediate-resolution spectroscopic observations. The new data reveal an hourglass morphology typical of bipolar PNe. A detailed analysis of its morphology and kinematics discloses the presence of a second pair of bipolar

lobes, making Kn 26 a new member of the subclass of quadrupolar PNe. The time-lap between the ejection of the two pairs of bipolar lobes is much smaller than their dynamical ages, implying a rapid change of the preferential direction of the central engine. The chemical composition of Kn 26 is particularly unusual among PNe, with a low N/O ratio (as of type II PNe) and a high helium abundance (as of type I PNe), although not atypical among symbiotic stars. Such an anomalous chemical composition may have resulted from the curtail of the time in the Asymptotic Giant Branch by the evolution of the progenitor star through a common envelope phase.

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Abell 48 – a rare WN-type central star of a planetary nebula

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A considerable fraction of the central stars of planetary nebulæ (CSPNe) are hydrogen-deficient. Almost all of these H-deficient central stars (CSs) display spectra with strong carbon and helium lines. Most of them exhibit emission line spectra resembling those of massive WC stars. Therefore these stars are classed as CSPNe of spectral type [WC]. Recently, quantitative spectral analysis of two emission-line CSs, PB 8 and IC 4663, revealed that these stars do not belong to the [WC] class. Instead PB 8 has been classified as [WN/WC] type and IC 4663 as [WN] type. In this work we report the spectroscopic identification of another rare [WN] star, the CS of Abell 48. We performed a spectral analysis of Abell 48 with the Potsdam Wolf–Rayet (PoWR) models for expanding atmospheres. We find that the expanding atmosphere of Abell 48 is mainly composed of helium (85 per cent by mass), hydrogen (10 per cent), and nitrogen (5 per cent). The residual hydrogen and the enhanced nitrogen abundance make this object different from the other [WN] star IC 4663. We discuss the possible origin of this atmospheric composition.

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Detailed atmospheric abundance analysis of the optical counterpart of the IR source IRAS 16559−2957

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We have undertaken a detailed abundance analysis of the optical counterpart of the IR source IRAS 16559−2957 with the aim of confirming its possible post-AGB nature. The star shows solar metallicity and our investigation of a large number of elements including CNO and $^{12}C/^{13}C$ suggests that this object has experienced the first dredge-up and it is likely still at RGB stage.

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Crystalline silicates in evolved stars. I. *Spitzer*/IRS spectroscopy of IRAS 16456−3542, 18354−0638, and 23239+5754

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We report the *Spitzer* Infrared Spectrograph (IRS) observations of three evolved stars: IRAS 16456−3542, 18354−0638, and 23239+5754. The 9.9–37.2 μm *Spitzer*/IRS high resolution spectra of these three sources exhibit rich sets of enstatite-dominated crystalline silicate emission features. IRAS 16456−3542 is extremely rich in crystalline silicates, with $> 90\%$ of its silicate mass in crystalline form, the highest to date ever reported for crystalline silicate sources.

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A proper motion study of the globular clusters M 4, M 12, M 22, NGC 3201, NGC 6362 and NGC 6752

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We derive relative proper motions of stars in the fields of globular clusters M 4, M 12, M 22, NGC 3201, NGC 6362 and NGC 6752 based on a uniform data set collected between 1997 and 2008. We assign a membership class for each star with a measured proper motion and show that these membership classes can be successfully used to eliminate field stars from color–magnitude diagrams of the clusters. They also allow for the efficient selection of rare objects such as blue/yellow/red stragglers and stars from the asymptotic giant branch. Tables with proper motions and photometry of over 87 000 stars are made publicly available via the Internet.

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New colour–mass to light relations: the role of the asymptotic giant branch phase and of interstellar dust

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Colour–M/L (mass-to-light) relations are a popular recipe to derive stellar mass in external galaxies. Stellar mass estimates often rely on near infrared (NIR) photometry, considered an optimal tracer since it is little affected by dust and by the "frosting" effect of recent star formation episodes. However, recent literature has highlighted that theoretical estimates of the NIR M/L ratio strongly depend on the modelling of the Asymptotic Giant Branch (AGB) phase. We use the latest Padova isochrones, with detailed modelling of the Thermally Pulsing AGB phase, to update theoretical colour–M/L relations in the optical and NIR and discuss the consequences for the estimated stellar masses in external galaxies. We also discuss the effect of attenuation by interstellar dust on colour–M/L relations in the statistical case of large galaxy samples.

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Dust properties in the Galactic Bulge

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It has been suggested that the ratio of total-to-selective extinction R_V in dust in the interstellar medium differs in the Galactic Bulge from its value in the local neighborhood. We attempt to test this suggestion. The mid-infrared hydrogen lines in 16 Galactic bulge PNe measured by the *Spitzer* Space Telescope are used to determine the extinction corrected Hβ flux. This is compared to the observed Hβ flux to obtain the total extinction at Hβ. The selective extinction is obtained from the observed Balmer decrement in these nebulae. The value of R_V can then be found. The ratio of total-to-selective extinction in the Galactic bulge is consistent with the value $R_V = 3.1$, which is the same as has been found in the local neighborhood. We conclude that the suggestion that R_V is different in the Galactic Bulge is incorrect. The reasons for this are discussed.

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The abundance of HCN in circumstellar envelopes of AGB stars of different chemical type

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Aims: A multi-transition survey of HCN (sub-) millimeter line emission from a large sample of AGB stars of different chemical type is presented. The data are analysed and circumstellar HCN abundances are estimated. The sample stars span a large range of properties such as mass-loss rate and photospheric C/O-ratio. The analysis of the new data allows for more accurate estimates of the circumstellar HCN abundances and puts new constraints on chemical models.

Methods: In order to constrain the circumstellar HCN abundance distribution a detailed non-LTE excitation analysis, based on the Monte Carlo method, is performed. Effects of line overlaps and radiative excitation from dust grains are included.

Results: The median values for the derived abundances of HCN (with respect to H_2) are 3×10^{-5} , 7×10^{-7} and 10^{-7} for carbon stars (25 stars), S-type AGB stars (19 stars) and M-type AGB stars (25 stars), respectively. The estimated sizes of the HCN envelopes are similar to those obtained in the case of SiO for the same sample of sources and agree well with previous results from interferometric observations, when these are available.

Conclusions: We find that there is a clear dependence of the derived circumstellar HCN abundance on the C/O-ratio of the star, in that carbon stars have about two orders of magnitude higher abundances than M-type AGB stars, on average. The derived HCN abundances of the S-type AGB stars have a larger spread and typically fall in between those of the two other types, however, slightly closer to the values for the M-type AGB stars. For the M-type stars, the estimated abundances are much higher than what would be expected if HCN is formed in thermal equilibrium. However, the results are also in contrast to predictions from recent non-LTE chemical models, where very little difference is expected in the HCN abundances between the various types of AGB stars.

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Magnetic field structure in single late-type giants: β Ceti in 2010–2012

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Aims: In the present work we study the behavior of the magnetic field and the line activity indicators of the single late-type giant β Ceti. Using spectro-polarimetric data, we aim to reconstruct the magnetic field structure on the star's surface and to present the first magnetic maps for β Ceti.

Methods: The data were obtained using two spectro-polarimeters – Narval at the Bernard Lyot Télescope, Pic du Midi, France, and ESPaDOnS at CFHT, Hawai'i. Thirty-eight circularly-polarized spectra have been collected in the period June 2010 – January 2012. The Least Square Deconvolution method was applied for extracting high signal-to-noise ratio line profiles, from which we measure the surface-averaged longitudinal magnetic field B_l. Chromospheric activity indicators Ca II K, Hα, Ca II IR (854.2 nm) and radial velocity were simultaneously measured and their variability was analysed together with the behavior of B_l. The Zeeman Doppler Imaging (ZDI) inversion technique was employed for reconstruction of the large-scale magnetic field and two magnetic maps of β Ceti are presented for two periods (June 2010 – December 2010 and June 2011 – January 2012).

Results: B_l remains of positive polarity for the whole observational period and shows significant variations in the interval 0.1–8.2 G. The behavior of the line activity indicators is in good agreement with the B_l variations. Searching for periodic signals in the Stokes V time-series, we found a possible rotation period of 215 days. The two ZDI maps show a mainly axisymmetric and poloidal magnetic topology and a simple surface magnetic field configuration dominated by a dipole. Little evolution is observed between the two maps, in spite of a 1 yr interval between both subsets. We also use state-of-the-art stellar evolution models to constrain the evolutionary status of β Ceti. We derive a mass of 3.5 $M_\odot$ and propose that this star is already in the central-helium burning phase.

Conclusions: Taking into account all our results and the evolutionary status of the star, we suggest that dynamo action alone may not be efficient enough to account for the high magnetic activity of β Ceti. As an alternate option, we propose that it may be an Ap star descendant presently undergoing central helium-burning and still exhibiting a remnant of the Ap star magnetic field.

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The enigmatic nature of the circumstellar envelope and bow shock surrounding Betelgeuse as revealed by *Herschel*. I. Evidence of clumps, multiple arcs, and a linear bar-like structure

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Context: The interaction between stellar winds and the interstellar medium (ISM) can create complex bow shocks. The photometers on board the *Herschel* Space Observatory are ideally suited to studying the morphologies of these bow shocks.

Aims: We aim to study the circumstellar environment and wind–ISM interaction of the nearest red supergiant, Betelgeuse.

Methods: Herschel PACS images at 70, 100, and 160 μm and SPIRE images at 250, 350, and 500 μm were obtained by scanning the region around Betelgeuse. These data were complemented with ultraviolet GALEX data, near-infrared WISE data, and radio 21 cm GALFA–H I data. The observational properties of the bow shock structure were deduced from the data and compared with hydrodynamical simulations.

Results: The infrared *Herschel* images of the environment around Betelgeuse are spectacular, showing the occurrence

of multiple arcs at 6–7′ from the central target and the presence of a linear bar at 9′. Remarkably, no large-scale instabilities are seen in the outer arcs and linear bar. The dust temperature in the outer arcs varies between 40 and 140 K, with the linear bar having the same colour temperature as the arcs. The inner envelope shows clear evidence of a non-homogeneous clumpy structure (beyond 15″), probably related to the giant convection cells of the outer atmosphere. The non-homogeneous distribution of the material even persists until the collision with the ISM. A strong variation in brightness of the inner clumps at a radius of 2′ suggests a drastic change in mean gas and dust density some 32 000 yr ago. Using hydrodynamical simulations, we try to explain the observed morphology of the bow shock around Betelgeuse.
Conclusions: Different hypotheses, based on observational and theoretical constraints, are formulated to explain the origin of the multiple arcs and the linear bar and the fact that no large-scale instabilities are visible in the bow shock region. We infer that the two main ingredients for explaining these phenomena are a non-homogeneous mass-loss process and the influence of the Galactic magnetic field. The hydrodynamical simulations show that a warm interstellar medium, reflecting a warm neutral or partially ionized medium, or a higher temperature in the shocked wind also prevent the growth of strong instabilities. The linear bar is probably an interstellar structure illuminated by Betelgeuse itself.

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The changing nebula around the hot R Coronæ Borealis star DY Centauri

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Among the distinguishing characteristics of the remarkable hot R Coronæ Borealis star DY Cen, which was recently found to be a spectroscopic binary, is the presence of nebular forbidden lines in its optical spectrum. A compilation of photometry from 1970 to the present suggests that the star has evolved to higher effective temperatures. Comparison of spectra from 2010 with earlier spectra show that between 2003 and 2010, the 6717 and 6730 A emission lines of [S II] underwent a dramatic change in their fluxes suggesting an increase in the nebula's electron density of 290 cm^{-3} to 3140 cm^{-3} from 1989 to 2010 while the stellar temperature increased from 19,500 K to 25,000 K. The nebular radius is about 0.02 pc, 60,000 times bigger than the semi-major axis of DY Cen binary system. Rapid changes of stellar temperature and its response by the nebula demonstrate stellar evolution in action.

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Annual parallax distance and secular motion of the "water fountain" source IRAS 18286−0959

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We report on results of astrometric observations of H_2O masers in the "water fountain" source IRAS 18286−0959

(I 18286) with the VLBI Exploration of Radio Astrometry (VERA). These observations yielded an annual parallax of I 18286, $\pi = 0.277 \pm 0.041$ mas, corresponding to a heliocentric distance of $D = 3.61^{+0.63}_{-0.47}$ kpc. The maser feature, whose annual parallax was measured, showed the absolute proper motion of $(\mu_\alpha, \mu_\delta) = (-3.2 \pm 0.3, -7.2 \pm 0.2)$ mas yr^{-1}. The intrinsic motion of the maser feature in the internal motions of the cluster of features in I 18286 does not seem to trace the motion of the bipolar jet of I 18286. Taking into account this intrinsic motion, the derived motion of the maser feature is roughly equal to that of the maser source I 18286 itself.
The proximity of I 18286 to the Galactic mid-plane ($z \approx 10$ pc) suggests that the parental star of the water fountain source in I 18286 should be intermediate-mass AGB/post-AGB star, but the origin of a large deviation of the systemic source motion from that expected from the Galactic rotation curve is still unclear.

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The wind of the M-type AGB star RT Virginis probed by VLTI/MIDI

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We study the circumstellar environment of the M-type AGB star RT Vir using mid-infrared high spatial resolution observations from the ESO–VLTI focal instrument MIDI. The aim of this study is to provide observational constraints on theoretical prediction that the winds of M-type AGB objects can be driven by photon scattering on iron-free silicate grains located in the close environment (about 2 to 3 stellar radii) of the star. We interpreted spectro-interferometric data, first using wavelength-dependent geometric models. We then used a self-consistent dynamic model atmosphere containing a time-dependent description of grain growth for pure forsterite dust particles to reproduce the photometric, spectrometric, and interferometric measurements of RT Vir. Since the hydrodynamic computation needs stellar parameters as input, a considerable effort was first made to determine these parameters. MIDI differential phases reveal the presence of an asymmetry in the stellar vicinity. Results from the geometrical modeling give us clues to the presence of aluminum and silicate dust in the close circumstellar environment (< 5 stellar radii). Comparison between spectro-interferometric data and a self-consistent dust-driven wind model reveals that silicate dust has to be present in the region between 2 to 3 stellar radii to reproduce the 59 and 63 m baseline visibility measurements around 9.8 μm. This gives additional observational evidence in favor of winds driven by photon scattering on iron-free silicate grains located in the close vicinity of an M-type star. However, other sources of opacity are clearly missing to reproduce the 10–13 μm visibility measurements for all baselines. This study is a first attempt to understand the wind mechanism of M-type AGB stars by comparing photometric, spectrometric, and interferometric measurements with state-of-the-art, self-consistent dust-driven wind models. The agreement of the dynamic model atmosphere with interferometric measurements in the 8–10 μm spectral region gives additional observational evidence that the winds of M-type stars can be driven by photon scattering on iron-free silicate grains. Finally, a larger statistical study and progress in advanced self-consistent 3D modeling are still required to solve the remaining problems.

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Investigation of dust properties of the proto-planetary nebula IRAS 18276−1431

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We investigate the circumstellar dust properties of the oxygen-rich bipolar proto-planetary nebula IRAS 18276−1431

by means of two-dimensional radiative transfer simulations of the circumstellar dust shell. The model geometry is assumed to have a torus and an envelope. The parameters of the dust and the dust shell are constrained by comparing the SED and NIR intensity and polarisation data with the models. The polarisation in the envelope reaches 50–60% and is nearly constant in the H and K_s bands in the observations. This weak wavelength dependence of the polarisation can be reproduced with a grain size distribution function for the torus: 0.05 μm $\leq a$ with $n(a) = a^{-(p=5.5)} \exp(-a/a_c = 0.3\mu\text{m})$. The power index p is significantly steeper than that for interstellar dust. Similar results have also been found in some other PPNs and suggest that mechanisms that grind down large particles may also have acted when the dust particles formed. The spectral opacity index β is found to be 0.6 ± 0.5 from the millimeter fluxes. This low value indicates the presence of large dust grains in the torus. We discuss two possible dust models for the torus. One has a size distribution function of 1.0 $\mu\text{m} \leq a \leq a_{\max} = 5,000.0$ μm with $n(a) = a^{-(p=2.5)}$ and the other is 1.0 $\mu\text{m} \leq a \leq a_{\max} = 10,000.0$ μm with $n(a) = a^{-(p=3.5)}$. The former has β of 0.633, but we are not able to find reasonable geometry parameters to fit the SED in the infrared. The latter has β of 1.12, but reproduces the SED better over a wide wavelength range. With this dust model, the geometric parameters are estimated as follows: the inner and outer radii are 30 au and 1000 au and the torus mass is 3.0 $M_\odot$. Assuming an expansion velocity of 15 km s^{-1}, the torus formation time and mass-loss rate are found to be $\sim$ 300 yr and $\sim 10^{-2}$ $M_\odot$ yr^{-1} respectively.

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Studies of NGC 6720 with calibrated HST WFC3 emission-line filter images – I: Structure and evolution

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We have performed a detailed analysis of the Ring Nebula (NGC 6720) using HST WFC3 images and derived a new 3-D model. Existing high spectral resolution spectra played an important supplementary role in our modeling. It is shown that the Main Ring of the nebula is an ionization-bounded irregular non- symmetric disk with a central cavity and perpendicular extended lobes pointed almost towards the observer. The faint outer halos are determined to be fossil radiation, i.e. radiation from gas ionized in an earlier stage of the nebula when it was not ionization bounded. The narrow-band WFC3 filters that isolate some of the emission-lines are affected by broadening on their short wavelength side and all the filters were calibrated using ground-based spectra. The filter calibration results are presented in an appendix.

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Studies of NGC 6720 with calibrated HST WFC3 emission-line filter images – II: Physical conditions

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We have performed a detailed analysis of the electron temperature and density in the Ring Nebula using the calibrated HST WFC3 images described in the preceding paper. The electron temperature (T_e) determined from [N II]and [O III] rises slightly and monotonically towards the central star. The observed equivalent width (EW) in the central region indicates that T_e rises as high as 13,000 K. In contrast, the low EWs in the outer regions are largely due to scattered

diffuse Galactic radiation by dust.
The images allowed determination of unprecedented small scale variations in T_e. These variations indicate that the mean square area temperature fluctuations are significantly higher than expected from simple photo-ionization. The power producing these fluctuations occurs at scales of less than 3.5×10^{15} cm. This scale length provides a strong restriction on the mechanism causing the large t^2 values observed.

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Detection of a multi-shell planetary nebula around the hot subdwarf O-type star 2MASS J19310888+4324577

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Context: The origin of hot subdwarf O-type stars (sdOs) remains unclear since their discovery in 1947. Among others, a post-Asymptotic Giant Branch (post-AGB) origin is possible for a fraction of sdOs.
Aims: We are involved in a comprehensive ongoing study to search for and to analyse planetary nebulæ (PNe) around sdOs with the aim of establishing the fraction and properties of sdOs with a post-AGB origin.
Methods: We use deep Hα and [O III] images of sdOs to detect nebular emission and intermediate resolution, long-slit optical spectroscopy of the detected nebulæ and their sdO central stars. These data are complemented with other observations (archive images, high-resolution, long-slit spectroscopy) for further analysis of the detected nebulæ.
Results: We report the detection of an extremely faint, complex PN around 2MASS J19310888+4324577 (2M 1931+4324), a star classified as sdO in a binary system. The PN shows a bipolar and an elliptical shell, whose major axes are oriented perpendicular to each other, and high-excitation structures outside the two shells. WISE archive images show faint, extended emission at 12 μm and 22 μm in the inner nebular regions. The internal nebular kinematics, derived from high resolution, long-slit spectra, is consistent with a bipolar and a cylindrical/ellipsoidal shell, in both cases with the main axis mainly perpendicular to the line of sight. The nebular spectrum only exhibits Hα, Hβ and [O III] $\lambda\lambda$4959,5007 emission lines, but suggests a very low-excitation ([O III]/H$\beta \simeq 1.5$), in strong contrast with the absence of low-excitation emission lines. The spectrum of 2M 1931+4324 presents narrow, ionized helium absorptions that confirm the previous sdO classification and suggest an effective temperature $\geq 60,000$ K. The binary nature of 2M 1931+4324, its association with a complex PN, and several properties of the system provide strong support for the idea that binary central stars are a crucial ingredient in the formation of complex PNe.

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Available from arXiv:1301.7210

Radio stars and their lives in the Galaxy

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This paper summarizes the three-day international workshop *Radio Stars and Their Lives in the Galaxy*, held at the Massachusetts Institute of Technology Haystack Observatory on 2012 October 3–5. The workshop was organized to provide a forum for the presentation and discussion of advances in stellar and solar astrophysics recently (or soon to be) enabled by the latest generation of state-of-the-art observational facilities operating from meter to submillimeter

wavelengths. The meeting brought together both observers and theorists to discuss how radio wavelength observations are providing new and unique insights into the workings of stars and their role in the Galactic ecosystem. Topics covered included radio emission from hot and cool stars (from the pre- to post-main-sequence), the Sun as a radio star, circumstellar chemistry, planetary nebulæ, white dwarf binaries and novæ, supernova progenitors, and radio stars as probes of the Galaxy.

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An H I imaging survey of asymptotic giant branch stars

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We present an imaging study of a sample of eight asymptotic giant branch (AGB) stars in the H I 21-cm line. Using observations from the Very Large Array, we have unambiguously detected H I emission associated with the extended circumstellar envelopes of six of the targets. The detected H I masses range from $M_{\rm HI} \approx 0.015$–0.055 $M_\odot$. The H I morphologies and kinematics are diverse, but in all cases appear to be significantly influenced by the interaction between the circumstellar envelope and the surrounding medium. Four stars (RX Lep, Y UMa, Y CVn, and V1942 Sgr) are surrounded by detached H I shells ranging from 0.36 to 0.76 pc across. We interpret these shells as resulting from material entrained in a stellar outflow being abruptly slowed at a termination shock where it meets the local medium. RX Lep and TX Psc, two stars with moderately high space velocities ($v_{\rm space} > 56$ km s^{-1}), exhibit extended gaseous wakes (~ 0.3 and 0.6 pc in the plane of the sky), trailing their motion through space. The other detected star, R Peg, displays a peculiar "horseshoe-shaped" H I morphology with emission extended on scales up to ~ 1.7 pc; in this case, the circumstellar debris may have been distorted by transverse flows in the local interstellar medium. We briefly discuss our new results in the context of the entire sample of evolved stars that has been imaged in H I to date.

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Available from arXiv:1301.7429

Conference Papers

Internal rotation of red giants by asteroseismology

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We present an asteroseismic approach to study the dynamics of the stellar interior in red-giant stars by asteroseismic inversion of the splittings induced by the stellar rotation on the oscillation frequencies. We show preliminary results obtained for the red giant KIC 4448777 observed by the space mission *Kepler*.

Poster contribution, published in the $40^{\rm th}$ Liège International Astrophysical Colloquium 'Ageing low mass stars: from red giants to white dwarfs', EPJ Web of conferences
Available from arXiv:1212.4758

Photometric behavior of five long-period pulsating stars

Larisa S. Kudashkina[1], *Ivan L. Andronov*[1] *and Lidia V.Grenishena*[1]

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The variation of average brightness during the time and the variation of the amplitude of the Mira-type stars T Cep, X CrB, U UMi, U Cyg, BG Cyg is studied. For the research, the observations of the members of the French association of observers of variable stars (AFOEV) covering almost 100 years are used. All stars show cyclic variations of the specified parameters. For T Cep, U UMi and U Cyg, the values of quasi-period of the variations of average brightness are about 1400, 1025 and 1680 days, respectively. For the stars T Cep, U UMi and BG Cyg, the period of the brightness variations changes, but we used a mean one. The dependences "average brightness – JD" and "amplitude – JD" are plotted. Results are discussed.

Oral contribution, published in Czestochowski Kalendarz Astronomiczny, 211 (2013), Proc. "Astrophisica Nova", ed. Bogdan Wszołek & Agnieszka Kuźmicz
Available from arXiv:1212.6724
and from http://www.ptma.ajd.czest.pl/publikacje_elektroniczne/cka13.pdf

Determination of cycle length of quasi-periodic signals. Application to semi-regular variables

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We review methods for determination of "quasi-periods" (or "cycle length") of signals of low coherence. Such type of variability was called "cyclic" for semi-regular red variables, or "quasi-periodic oscillations" (QPO) for fast variability in cataclysmic variables and related objects. Methods are illustrated by application to AF Cygni.

Oral contribution, published in Czestochowski Kalendarz Astronomiczny, 139 (2013), Proc. "Astrophisica Nova", ed. Bogdan Wszołek & Agnieszka Kuźmicz
Available from arXiv:1212.6708
and from http://www.ptma.ajd.czest.pl/publikacje_elektroniczne/cka13.pdf

Nucleosynthesis in massive AGB stars with delayed superwinds: implications for the abundance anomalies in globular clusters

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We present nucleosynthesis predictions for massive (5–7 $M_\odot$) asymptotic giant branch (AGB) stars of solar metallicity where we delay the onset of the superwind to pulsation periods of P = 700–800 days. We found that delaying the superwind in solar metallicity massive AGB stars results in a larger production of s-process elements, something that would be also expected at lower metallicities. These new models and the available observations show that massive C–O core AGB stars in our Galaxy and in the Magellanic Clouds experience considerable third dredge-up (TDU). Thus, if massive AGB stars at the metallicities of the Globular Clusters (GCs) also experience deep TDU, then these stars would not be good candidates to explain the abundance anomalies observed in most GCs. However, more massive AGB stars (e.g., near the limit of C–O core production) or super-AGB stars with O–Ne cores may not experience very

efficient TDU, producing the high He abundances needed to explain the multiple populations observed in some GCs.

Poster contribution, published in "Reading the book of globular clusters with the lens of stellar evolution", Mem. S. A. It., eds. P. Ventura, C. Charbonnel, M. Castellani & M. Di Criscienzo
Available from arXiv:1301.1492

Role of bulk flow in turbulent convection

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In this paper we present scaling of large-scale quantities like Peclét and Nusselt numbers, and the dissipation rates of kinetic energy and entropy. Our arguments are based on the scaling of bulk quantities and earlier experimental and simulation results. We also present the inertial-range properties of spectra and fluxes of kinetic energy and entropy.

Oral contribution, published in "Senfest", International Conference on Complex Processes in Plasmas and Nonlinear Dynamical Systems
Available from arXiv:1301.1240

How do the mass-loss rates of red-supergiants determine the fate of massive stars?

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Mass-loss rates are one of the most relevant parameters determining the evolution of massive stars. In particular, the rates at which the star loses mass during the red-supergiant (RSG) phase is the least constrained by the observations or theory. In this paper, we show how the mass loss during the RSG phase affects the later evolution of the star, as well as the final type of supernova towards which it leads. We also discuss some possibilities to discriminate between blue stars that went through a RSG phase and those which remained in the blue part of the Hertzsprung–Russell diagram.

Oral contribution, published in the Betelgeuse workshop held in Paris (November 2012), EAS Publications Series
Available from arXiv:1301.2978

Review Paper

Late stages of stellar evolution – *Herschel*'s contributions

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Cool objects glow in the infrared. The gas and solid-state species that escape the stellar gravitational attraction of evolved late-type stars in the form of a stellar wind are cool, with temperatures typically < 1500 K, and can be ideally studied in the infrared. These stellar winds create huge extended circumstellar envelopes with extents approaching 10^{19} cm. In these envelopes, a complex kinematical, thermodynamical and chemical interplay determines the global

and local structural parameters. Unraveling the wind acceleration mechanisms and deriving the complicated structure of the envelopes is important to understand the late stages of evolution of $\sim 97\%$ of stars in galaxies as our own Milky Way. That way, we can also assess the significant chemical enrichment of the interstellar medium by the mass loss of these evolved stars. The *Herschel* Space Observatory is uniquely placed to study evolved stars thanks to the excellent capabilities of the three infrared and sub-millimeter instruments on board: PACS, SPIRE and HIFI. In this review, I give an overview of a few important results obtained during the first two years of *Herschel* observations in the field of evolved low and intermediate mass stars, and I will show how the *Herschel* observations can solve some historical questions on these late stages of stellar evolution, but also add some new ones.

Published in Advances in Space Research
Available from arXiv:1212.4861

Announcements

Request for Input

The conference "Shaping E-ELT Science and Instrumentation" workshop is being organised at ESO, Garching from 25$^{\text{th}}$ February to 1$^{\text{st}}$ March 2013 (http://www.eso.org/sci/meetings/2013/eelt2013.html)

I agreed to review the possibilities offered by mid-infrared astronomy on the E-ELT in the area of evolved stars and their environment and the instrument requirements that arise from these science cases.

Some of the possibilities of a MIR instrument are captured in the proposed METIS instrument (http://metis.strw.leidenuniv.nl/index.php)

If you have any ideas, or even a concrete examples, please e-mail me by February 20$^{\text{th}}$ at the latest and I will include and acknowledge this in my presentation.

Many thanks,
Martin Groenewegen
(martin.groenewegen @ oma.be)

Adaptable Radiative Transfer for Submillimetre Telescopes

Submillimeter observations are a key for answering many of the big questions in modern-day astrophysics, such as how stars and planets form, how galaxies evolve, and how material cycles through stars and the interstellar medium. With large facilities such as ALMA and *Herschel*, new windows have opened to study these questions. Within the ASTRONET first joint call for proposals, *Common Tools for Future Large Submillimeter Facilities*, we have developed a next generation model suite *Adaptable Radiative Transfer Innovations for Submillimeter Telescopes (*ARTIST*)* for comprehensive multi-dimensional radiative transfer calculations of the dust and line emission, as well as their polarization, to help interpret observations with these groundbreaking facilities.

The ARTIST package consists of:

> An innovative radiative transfer code (LIME; Brinch & Hogerheijde 2010, A&A, 523, A25) that allows simulations of sources with arbitrary multi-dimensional (1D, 2D, 3D), given by analytical expression or defined on a grid (e.g., taken from HD/MHD codes). It utilizes an adaptive gridding method, which ensuring rapid convergence.

Unique tools for modeling the polarization of dust emission (Padovani et al. 2012, A&A, 543, A16) and eventually line emission (Kuiper et al., in prep.), information that will come with standard ALMA observations.

A library of commonly used analytic/semi-analytic models as well as a comprehensive graphical user and Python interface.

ARTIST is now available for download at `http://youngstars.nbi.dk/artist`. It can either be downloaded as a fully workable package on most common Linux flavors and Mac OS X with a number of dependencies – or as a virtual machine that can be run directly with minimum installation of ancillary software. For further questions about ARTIST consult the webpage or contact Jes Jørgensen (ARTIST PI) at `jeskj@nbi.dk`. For specific issues regarding the modeling of AGB and post-AGB stars, contact Wouter Vlemmings at `wouter.vlemmings@chalmers.se`.

See also http://youngstars.nbi.dk/artist

VLTI school 2013
High angular resolution for stellar astrophysics Stellar activity, surface dynamics, fundamental parameters, exo-planetary systems, pulsations

With the advent of large and multi-telescope arrays in the recent years, interferometry has reached a new area. Interferometric facilities are becoming more and more open to non-specialist astronomers, and the Very Large Telescope Interferometer (VLTI) is a good example of a interferometric fully open facility.

We organize a summer school to train astrophysicists to the use of the VTLI and also other facilities with the current generations of instruments. The aim of the school is to offer to Ph.D. students, post-doctoral and permanent researchers and introduction to the technique of long-baseline optical/infrared stellar interferometry, data reduction, astrophysics, namely: stellar physics including the hot topics of stellar activity, evolution, hydrodynamics, star hosting planets, the determination of the fundamental parameters, circumstellar envelopes, young stellar objects, as well as the role of binaries.

The school will be held in the heart of Alpine mountains in Barcelonnette, Côte d'Azur, France from 9th–21st September 2013. Barcelonnette is a typical alpine town, located in the heart of the Mercantour French National Park, with many possibilities of sportive and non-sportive activities like hiking, or wildlife discovery. The school will also be located at one throw of the Hypertelescope prototype under construction, which is a novel type of stellar interferometer (a visit is foreseen during the school).

important dates:
February 1st, 2013: First announcement and web site
February 15th, 2013: Early registration opened
May 31st, 2013: Deadline for financial support
June 30th, 2013: Deadline for early registration and payment (100 euro)
July 31th, 2013: Deadline for late registration and payment (150 euro)
September 9th, 2013: The VLTI-school starts

On behalf of the Scientific Organizing Committee,
Andrea Chiavassa

See also http://vltischool.sciencesconf.org